Deliverable D6.2

Year 2 report on communication, dissemination and standardisation activities

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Abstract

The B5G-OPEN project's WP6, focusing on communication, dissemination, and standardization activities, plays a vital role in harnessing the research and development endeavours of project partners. This report, titled "*Year 2 Report on Communication, Dissemination, and Standardisation Activities*," provides a comprehensive overview of the activities undertaken during the second year of the project.

This report recalls on the effective internal communication channels among B5G-OPEN partners, the project knowledge repository, the formulation of strategic plans and methods for dissemination. This document also reports in detail on the dissemination activities, 5G-PPP contributions and standardisation contributions. Additionally, this report presents the exploitation plans from partners and highlights the excellent innovations that are analysed and remarked by the European Commission's Innovation Radar platform.

As the project advances into Year 3, this report emphasises the continued commitment of the B5G-OPEN project towards advancing the domains of communication, dissemination and standardisation within the context of optical communications.

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GLOSSARY

Abbreviations/Acronym	Description
5G-PPP	5G Infrastructure Public Private Partnership
AP	Access Point
CA	Consortium Agreement
DWDM	Dense Wavelength Division Multiplexing
ECOC	European Conference on Optical Communication
EuCNC	European Conference on Networks and Communication
ETSI	European Telecommunication Standards Institute
FDM/FDMA	Frequency Division Multiplexing/Frequency Division Multiple Access
GLOBECOM	Global Communications Conference
GUI	Graphical User Interface
ICTON	International Conference on Transparent Optical Networks
IETF	Internet Engineering Task Force
IPR	Intellectual Property Protection
ITNAC	International Telecommunication Networks and Applications Conference
ITU	International Telecommunication Union
JLT	IEEE/OSA Journal of Lightwave Technology
JOCN	IEEE/OSA Journal of Optical Communication and Networks
KPI	Key Performance Indicator
MOPA	Mobile Optical Pluggable Alliance
MSA	Multi-Source Agreement
NFV	Network Function Virtualization
NFV-SDN	Network Function Virtualization and Software Defined Networks
OECC	Opto-Electronics and Communications Conference
OFC	Optical Fiber Communications Conference and Exhibition
ONDM	Optical Network Design and Modelling
ONF	Open Networking Foundation
P2MP	Point-to-multipoint
PLI-aware RMSA	Physical Layer Impairment-aware Routing and Spectral Assignment Algorithm
QMR	Quarterly Management Report
QoE	Quality of Experience
RIA	Reference Implementation Agreements
RPC	Remote Procedure Calls
SB	Steering Board
SC	Steering Committee
SDN	Software Defined Networks
SDO	Standards Developing Organization

SME	Small and Medium-sized Enterprise
SONIC	Software for Open Networking in the Cloud
SUM	IEEE Photonics Society Summer Topicals
TAPI	Transport API
TB	Technical Board
TC	Technical Committee
TDM/TDMA	Time Division Multiplexing/Time Division Multiple Access
TIP	Telecom Infra Project
VIM	Virtual Infrastructure Management
WG	Working Group
WP	WorkPackage

EXECUTIVE SUMMARY

This document offers a comprehensive summary of the achievements in communication, dissemination and standardisation activities within the B5G-OPEN project during its second year. It outlines the methodologies and tools employed to support the coordination of Work Package 6 (WP6), emphasizing its vital role in these domains.

This report firstly recalls the tools and methods used for internal communications among partners. It outlines the methodology and repository employed for sharing documentation and storing data, further ensuring effective collaboration and information exchange. Within WP6, dissemination efforts are detailed. This includes coordinated contributions to major conferences and workshops, proposal preparation for events, active involvement in 5G-PPP activities, participation in standardisation activities, and the coordination of joint publications in high-impact factor journals. Additionally, the exploitation plans of the partners are reported while the several innovations also highlighted by European Commission's Innovation Radar initiative have been described. These innovations indicate some of the highly potential exploitable items from the B5G-OPEN results.

The achievements of WP6 in the second year of the B5G-OPEN project have been noteworthy, spanning a wide spectrum of activities across conferences, journals, workshops, 5G-PPP and standardisation. These efforts are instrumental in advancing the project's objectives and promoting its research outcomes.

Document Structure

This document is structured as follows.

In the **introduction,** a short summary on the overall status of the project activities is presented.

Next, the B5G-OPEN **dissemination strategy** is recalled which includes dissemination coordination, detailed plans and objectives. Updated information on the website is provided. In year 2, B5G-OPEN 5G-PPP representatives have kept active participation in 5G-PPP activities, and the contributions are herein reported.

Then the **dissemination impact in year 2** is reported, including coordinated contributions to major conferences and workshops, proposal preparation for events, the submission of joint publications in high-impact factor journals and participation in standardisation activities.

In the following section, the exploitation plan for both individual partner and a sub-group of partners have been briefly presented. Additionally, the five innovations which have been highlighted by the European Commission's **Innovation Radar** are presented. These innovations show great potential on the exploitation of B5G-OPEN results.

The last section summarises this document.

1 INTRODUCTION

In Year 1, we established a solid groundwork that formed the basis for our ambitious goals. In Year 2, we are proud to report substantial progress, informed by the insights gleaned from our preceding year's endeavours. This report serves as a medium through which we provide a comprehensive update on our activities within the spheres of communication, dissemination, and standardization.

On the administrative and internal communication tools, we maintain continuity with the tools reported in the previous year's document. These tools, which include our online repository and live communication platform, continue to serve as essential components of our project infrastructure. The project logo, project template, file naming conventions, and acknowledgment text remain unchanged, ensuring consistency in our project's identity and documentation. Additionally, our mailing list remains an active channel for internal communication and collaboration.

Our project website and social media channels continue to play an important role in promoting the activities and achievements of the B5G-OPEN project. The website remains a dynamic platform for sharing project updates, research findings, and relevant resources with both our consortium members and the broader community. Our presence on social media platforms such as LinkedIn, Twitter, and YouTube remain active, enabling us to engage with stakeholders, share our progress, and foster meaningful discussions within the field.

In the terms of publications and events, we are pleased to report that we have consistently achieved commendable numbers in both areas. Our commitment to disseminating high-quality research findings remains unwavering. Moreover, we actively contribute to 5G-PPP and standardization activities, ensuring that our research aligns with industry standards and facilitates broader industry advancements.

In a noteworthy development, we are pleased to announce the acceptance of all five innovations submitted to the European Commission's Innovation Radar. This recognition emphasises the innovative nature of our project and highlights the potential impact of our contributions to the field. We will continue to engage with the European Commission's Innovation Radar, leveraging this recognition to further promote our project's innovations on a broader scale.

As we progress into Year 3 of the B5G-OPEN project, we remain our commitment to advancing the fields of communication, dissemination, and standardization. The achievements and milestones outlined in this report represent our dedication to driving innovation, knowledge sharing, and collaboration. We look forward to the opportunities and challenges that lie ahead as we continue to shape the future of optical communications and its vital role in the digital era.

2   DISSEMINATION STRATEGY

For a complex project such as B5G-OPEN with a wide set of partners, the managed dissemination activities ensure that publications, tasks and objectives are adequately planned and delivered.

This should avoid inferior quality publications and inefficient use of time and resources. It is also important to avoid partial or missed tasks and objectives.

The project dissemination and standardisation efforts are split into the following sub-level areas: industry dissemination, scientific dissemination, specification, and standardisation contributions.

To achieve quality publications across the areas mentioned we use a set of processes and tools, a variety of external platforms and channels, and social media platforms, to disseminate our output to the industry, academia and public. These have been reported in D6.1. Some updates on the project website have been given in the following sections.

The project coordination, dissemination plan and objectives remain the same as reported last year. The involvements within the 5G-PPP have been updated and the contributions during this year have been reported. The arrangement for the generated data by partners in B5G-OPEN has also been clarified in the last section.

2.1   PROJECT WEBSITE

As reported in D6.1, the project public area is accessible for any Internet user. The website (https://www.b5g-open.eu/) is mainly managed and updated by CNIT, leveraging on content provided by WP6 contributors. The project site structure remains same as reported previously. The updated consortium logos are shown in Figure 2.1.

CONSORTIUM

Figure 2.1: Project website – Consortium

2.2 DISSEMINATION COORDINATION

2.2.1 Internal Dissemination Coordination

There are periodical bi-weekly conference calls for the individual work package where partners can catchup and update with regards to project advancements. Also, in Year 2 the project has held two plenary sessions:

1. January 2023, as an online meeting
2. April 2023, in Massy (close to Paris), France

These plenary sessions provided an opportunity for internal dissemination. During the sessions, project partners could meet personally and discuss in length the relevant topics. In addition to these sessions, the online conference calls allowed partners to be periodically updated with regards to project advancements.

The next plenary (Nov. 13th – 16th) has been already planned and it will be hosted in Pisa, at CNIT.

2.2.2 External Dissemination Coordination

Concerning dissemination to external channels, posts to multiple different platforms are targeted to reach a broad audience. Such platforms include, but are not limited to, social media, the project website, blogs, newsletters, news articles, participation to conference workshop,

and press releases. The published information should provide updates based on the research output of the project partners. The coordination also encourages partners to submit articles to any relevant scientific journals, peer-reviewed conferences, and books, solidifying the presence of the project within those mediums to reach a broader audience.

2.3   PROJECT DISSEMINATION PLAN

The project dissemination plan is recalled here which covers diverse periods of the project and has been reported in D6.1.

Period 1: includes the creation of the project website increasing the visibility of the project; the definition of the dissemination strategy document(s); the identification of which standards developing organizations (SDOs) to target for B5G-OPEN proposals; reporting the first architecture approach, identifying the principal research challenges; and the creation of the project education programme, appropriate for industry and academia (MSc and PhD programs).

Period 2: Publication of early findings in scientific journals; create new education resources scoping the solution and involved technologies; the submission of first technical reports to SDO with more precise and specified solutions; continuous development and industry collaboration of SDO proposals; participation with the project education programme in workshops, webinars and lectures on MSc and PhD programs.

Period 3: Publication of techno-economics data, infrastructure, experiments, services and applications, demos, and other relevant knowledge; formal adoption of specification and standards, and publication as standards.

2.3.1   Planned Scientific Publications

The B5G-OPEN project considers two main methods to disseminate scientific results: conferences and publications.

Conferences: The B5G-OPEN project will participate and present the knowledge, results, and key innovations at academic and industry conferences.

Publications: The B5G-OPEN project expects to publish over 5 publications in journals, 10 proceeding articles (per year), magazines, whitepapers, specifications, and standards, that highlights the scientific and industry technology leadership.

2.3.2   Organisation of Planned Events

During the project duration, the B5G-OPEN partners participate in several activities. Some of them are planned from the beginning, and outstanding events should be required according to the course of the project.

Project Workshops: The partners will demonstrate the results of the project with best practices and successful studies, applications, functions, and services tested within the B5G-OPEN framework and overall 5G PPP community. They will contribute to demonstrating the value of B5G-OPEN across all European ICT innovators.

Joint 5G PPP workshop and sessions: The project will participate in the presentations and exhibitions in the 5G PPP events including Optical Fiber Conference (OFC), 5G Global events,

European Conference on Networks and Communication (EuCNC), European Conference on Optical Communication (ECOC), Optical Network and Design Modelling (ONDM) conference, etc.

2.4 PROJECT DISSEMINATION OBJECTIVES

The dissemination plan is designed to maximize the external knowledge of B5G-Open proposal in order to influence network operators, equipment vendors, Small Medium Enterprises (SMEs), and the research organizations to adopt and exploit the proposed architectures and technologies. This will be achieved with a thorough dissemination of the project outcomes to relevant industry and scientific communities through:

• Scientific dissemination in conferences (industry and academic) and academic journals. We expect to publish over forty journal articles – after two years from the start of the project, magazines, whitepapers, specifications, and standards (Table 1);

• Organization of events such as: B5G-OPEN Workshops and joint 5G PPP workshop/sessions;

• Educational activities for students moving to industrial roles to promote the development of skills and knowledge necessary to design, build and deploy the B5G-OPEN infrastructure;

• Standardisation and Open-Source activities to significantly impact SDOs (Table 2);

• Dissemination with the 5GPPP by participating in Steering Board activities, where program level decisions will be taken on actions to achieve the objectives of the program.

Table 1 – Summary of targeted Yearly dissemination activities and verification

Dissemination Activity and Verification Plan	Year 1	Year 2	Year 3
Publication in selected peer-reviewed Journals	5	10	10
Presentation and Publication at selected conferences	10	15	15
Organization of Workshops/Symposia	-	1	1
Participation at industry conference/workshops/events	1	1	2
Contribution to SDOs (different WG contributions)	1	2	2

Table 2 – Standardisation and Open-Source activity plan

Standardisation	By completion of the Project
SDO contributions (individual drafts, documents, interop reports, best practices, and applicability documents)	4+ contributions.
Contributions to Open-Source projects, including code, documentation, bug fixes, features, and testing reports.	Contributions to at least 2 Open-Source projects.

2.5 5G-PPP

In D6.1, the 5G-PPP website (https://5g-ppp.eu/)) has been introduced regarding the background and main objectives. B5G-OPEN was added to the 5G-PPP website and a specific e-mail was also assigned to the project:

✓ 5G-PPP website: https://5g-ppp.eu/b5g-open/
✓ B5G-OPEN 5G-PPP e-mail: b5gopen-contact@5g-ppp.eu.

All B5G_OPEN partners have been informed about the contractual commitment of the 5G-PPP as well as its organizational structure. Indeed, all partners have acknowledged the roles and commitments of the European Commission, the 5G-PPP partnership board, the 5G Infrastructure Association, and the 5G for Europe and commit to constructive interactions with these bodies as part of B5G-OPEN research and impact activities.

2.5.1 B5G-OPEN 5G-PPP representatives and participation in working groups (WGs)

This section recalls in detail those activities performed by the B5G-OPEN partners and representatives in each of the working groups (WGs) as part of the 5G-PPP related activities as described in D6.1.

Aiming at exploiting synergies and enhancing collaboration with 5G-PPP projects as well as participating in joint dissemination activities while actively contributing to the different WGs, the following representatives were allocated to each one of the 5G-PPP WGs and have been updated since D6.1:

5G-PPP WG	Main representative	Partner	Second representative	Partner
Vision and Societal	Javier Garcia	TID	Alexandros Stavdas	OLC-E
TMV KPIs	Emilio Hugues Salas	BT	Vangelis Kosmatos	OLC-E
Trials	Oscar González	TID		
Software Networks	Ramón Casellas	CTTC	Behnam Shariati	HHI
5G Architecture	Albert Rafel	BT		
Pre-standardization	Antonio Napoli	INF-D		
O-RAN WG9 "Open X-haul Transport Working Group"	Roberto Mercinelli	TIM	Annachiara Pagano	TIM
	Filippo Cugini	CNIT	Javier Garcia	TID

Goals and main objectives for each of the WGs are detailed below as follows:

✓ <u>Vision and Societal Challenges WG</u>: This specific WG aims to develop a consensus in Europe on 5G systems, infrastructures, and services as well as to identify the societal, economic, environmental, business, and technological benefits that can be obtained from the realization of 5G implementation.
✓ <u>Test, Measurement and KPIs Validation</u>: 5G network will bring new services and technologies, and therefore it will be required to evaluate the 5G related KPIs accordingly. The purpose of the Group is to bring together the projects that have common interest in topics towards the development of Test & Measurements and validation methods, test cases, and procedures that can support the verification of the KPIs.
✓ <u>Trials WG</u>: The WG was launched to develop the European Trial Roadmap based on the 5G Manifesto. The scope of the activities is threefold:

- o To facilitate the involvement of verticals in the trial's roadmap.
- o To discuss and define business principles underpinning the economic viability of trials.
- o To consider and coordinate the activity on trials with other relevant initiatives at international level.

✓ Software Networks WG: The objective of this WG is to analyse the applicability of research topics towards Software Defined Networks (SDN) and Network Function Virtualization (NFV) and foster the development of related activities by the 5G-PPP projects.

✓ 5G Architecture WG: The goal of this WG is to serve as a common platform that will facilitate the discussion between 5G-PPP projects developing architectural concepts and components as well as promote any discussions based on the KPI's as described by 5GPPP.

✓ Pre-Standardisation WG: This WG focuses on developing a roadmap of relevant standardisation and regulatory topics for 5G by identifying the standardisation and regulatory bodies to align with e.g. ETSI, 3GPP, IEEE and other relevant standards bodies such as ITU-R and WRC, as well as evaluating roadmaps in international level.

✓ Open X-haul Transport WG: The WG shall focus on the transport domain – consisting of transport equipment, physical media and control / management protocols associated with the transport network underlying the assumed Ethernet interfaces (utilized for fronthaul, mid-haul and backhaul). The WG shall focus on specifying deployment architectures, requirements and solutions, identify gaps and proposals towards existing transport SDOs. The WG shall also coordinate requirements from other WGs, negotiating as necessary to align requirements among the WGs.

Indeed, the work being performed in the above mentioned WGs falls under the same scope and objectives as B5G-OPEN and they are therefore all of interest for the project.

The consortium also develops interactions with the 5G-IA governing bodies (i.e. Steering Board and Technical Board) by keeping an active communication and regularly attending meetings calls.

5G-PPP Governing body	Main representative	Partner	Second representative	Partner
Steering Board (SB)	Javier Garcia	TID	Oscar González	TID
Technical Board (TB)	Filippo Cugini	CNIT	Oscar González, Alexandros Stavdas	TID, OLC-E

- 5G-PPP Steering Board: It consists of mandated representatives of each 5G-PPP project who are people with the responsibility to decide on common actions and initiatives of the programme.
- 5G-PPP Technical Board: The technical board addresses the inter-working of the technical solutions developed within the projects and also ensures coherence and consistency across the programme.

2.5.2   B5G-OPEN contributions to 5G-PPP

The contribution to 5G-PPP can be differentiated into three main streams: (i) contributions to the WGs; (ii) (co)-organization of workshops; and (iii) collaboration to prepare white papers.

In Year 2, B5G-OPEN delivers the following contributions:

- Vision and Societal:
    - proposal for workshop at EuCNC entitled "Convergence of Platforms and Technologies for an End-to-End Optimal Use of the ICT Resources", submitted by Alexandros Stavdas (OLC-E), Raul Munoz (CTTC) and Juan Palacios (Telefonica). Also, OLC-E participated in the discussions of this WG.
- Test, Measurement WG:
    - B5G-OPEN has been presented to the WG and feedback was positive. B5G-OPEN contributed to the white paper "Beyond 5G/6G KPI Measurement", which has been also presented at the EuCNC 2023.
- ICT-52 joint workshop (2023, January) where B5G-OPEN was represented by Óscar González de Dios (TID).
- Trial/ pilot WG:
    - B5G-OPEN trials/pilot (the final demos) are planned in the second half of the project. The discussion of this activity is ongoing.
- Contributed to a workshop proposal at IEEE ICC '23 (Rome) with the co-participation in joint 5G-PPP workshop called "AI/ML driven Autonomous 6G networks". Title of the proposal: "Real-time Autonomous Optical Network Operation: from Vision to Development in B5G-OPEN", led by UPC.
- The project has always been represented in all 5G-PPP Steering Board meetings by Mr. Javier Garcia Rodrigo.

2.6 GENERATED DATA

Throughout the lifecycle of B5G-OPEN project, a substantial volume of data will be generated, reflecting the research activities and findings. It is crucial to outline the approach and strategies for handling these datasets, including decisions regarding their long-term preservation, as well as the establishment of an online repository for selected datasets. This section provides an overview of our data management framework, highlighting key aspects of data generation, storage, and preservation within the B5G-OPEN project by each partner.

Partner/ Third Party	Type of data	Will be kept or not (after end of B5G-OPEN) [Y / N]	Online repository [Y / N]
1. TID	As of September 14, TID is not expecting to generate data sets. As soon as TID gets results from the experimentation activities, an update on data management will be provided	N	N

1.1. UC3M	Not expecting to generate data for dissemination activities	N	N
1.2. TSA	As of 2023 September 14, TID is not expecting to generate data sets. As soon as TID gets results from the experimentation activities, an update on data management will be provided	N	N
2. TIM	Not expecting to generate data for dissemination activities	N	N
3. BT	Not expecting to generate data for dissemination activities	N	N
4. INF-D	Not expecting to generate data for dissemination activities	N	N
5. INF-P	Not expecting to generate data for dissemination activities	N	N
6. ADTRAN	Not expecting to generate data for dissemination activities	N	N
7. Nokia	Power spectral density for 16-QAM & QPSK on a 7-node meshed network testbed	N	N
8. CNIT	Not expecting to generate data for dissemination activities	N	N
8.1 CNR	Not expecting to generate data for dissemination activities	N	N
9. CTTC	The data is synthetic, obtained by running simulations on the TAPI Network Orchestrator. A simulation consists of the arrival and departure of connections following some pre-defined statistic. It depends on the pre-defined topology and relevant parameters. The data is the stream of network events that is generated by the TAPI orchestrator regarding topology and connectivity changes in the network. Each event is timestamped and contains the relevant information	N The data can be generated on demand	N No plans to keep the data unless it is used for some experiment that uses it beyond feasibility assessment and proof of concept
10. UPC	A dataset containing synthetic IQ optical constellation data for 16-QAM optical connections generated with a Matlab-based coherent WDM optical system simulator	Y	Available via this link (https://doi.org/10.34810/data146/2)

11. HHI	Networking KPIs and parameters collected from the testbed, experimental dataset generated during the course of the project	Y	will be published at https://www.hhi.fraunhofer.de/networkdata
12. OpenLight	Not expecting to generate data for dissemination activities	N	N
13. ELIG	Not expecting to generate data for dissemination activities	N	N
14. TuE	Not expecting to generate data for dissemination activities	N	N
15. pureLiFi	KPIs and test results collected from the experimental set-up and demo implementation	Y	N

3   DISSEMINATION IMPACT IN YEAR 2

3.1   DISSEMINATIONS WITH PUBLICATIONS

3.1.1   Summary

B5G-OPEN has been active in several dissemination activities. The number of publications has been significantly higher than the initial plan. B5G-OPEN partners publish at top IEEE/OPTICA conferences and on the leading magazines. Many partners have been invited to talk at workshop, symposia, and various scientific collaborative events.

3.1.2   Disseminations by Type

The dissemination by type is reported in the next two sections.

3.1.3   B5G-OPEN Presence in Industry Conferences

Table 3 (below) lists the industry conferences where B5G-OPEN had or will have a presence.

Table 3 List of Industry Conference with B5G-OPEN's Presence

Conference or Workshop Name	# Contributions
International Telecommunication Networks and Applications Conference (ITNAC 2022)	1
IEEE Conference on Network Function Virtualization and Software Defined Networks (NFV-SDN 2022)	1
23rd International Conference on Transparent Optical Networks (ICTON 2023)	1
2023 Opto-Electronics and Communications Conference (OECC)	1
Optical Fiber Communications Conference and Exhibition (OFC 2023)	17
The 27th International Conference on Optical Network Design and Modelling (ONDM 2023)	5
OPTICA Advanced Photonics Congress 2023	1
European Conference on Networks and Communications (EuCNC 2023)	2
European Conference on Optical Communication (ECOC 2023)	9
Arxiv Technical report	1
SPIE Photonics West	1
IEEE SUM	1
IEEE Globecom	1 submitted
IMOC 2023	1
OFC 2024 (submission)	7 submitted
TOTAL in Year 2	**51 (8 submissions)**
TOTAL in Year 1 + Year 2	**84 (8 submissions)**

3.1.4   B5G-OPEN Publications in Journals

The table below lists the scientific journal published or submitted by B5G-OPEN partners.

Magazine title	# Contributions
IEEE / OPTICAL J. of Optical Communications and Networking (JOCN)	15 (7 submitted)

IEEE / OPTICAL J. of Lightwave Technology (JLT)	4
IEEE Network Magazine	1
IEEE Photonics Technology Letters (PTL)	1
Sensors - Secure and Reliable Autonomous Optical Communications and Networks	1
Optics Continuum	2
TOTAL in Year 2	**24 (7 submissions)**
TOTAL in Year 1 + Year 2	**40 (7 submissions)**

3.2 STANDARDISATION ACTIVITY

Standardisation bodies active in the field of technology covered by B5G-OPEN have been identified and contact persons from the project that are already contributing to them have been found out. Thus, paths for submitting contributions have been defined.

Relevance of different standards has been checked and project partners have contributed to the following standardisation bodies and activities:

1. ETSI ISG F5G
2. IETF
3. ITU
4. ONF TAPI
5. openConfig
6. openROADM
7. openXR forum
8. O-RAN
9. TIM MUST

Hereafter some examples of contributions:

3.2.1 ETSI ISG F5G

HHI has contributed to ETSI ISG F5G with two proof-of-concept demonstrations that require fiber optic-based broadband connectivity. The two proof-of-concepts focused on edge/cloud based visual inspection for quality assurance and edge/cloud-based control of automated guided vehicles. These use-cases are relevant to B5G-OPEN, as the broadband connectivity interconnecting edge/cloud and factory shop floors rely on passive optical networking technologies. HHI has submitted two proof-of-concept proposals to ETSI ISG F5G to perform the demonstrations. Both proposals were accepted.

1 OIF

Telefonica is hosting an OIF interoperability event on IP and optical convergence demonstrating Innovation across 400ZR+ and CMIS. Main interoperability tests consist of a full implementation

of 400ZR and 400ZR+ and CMIS implementations across numerous DWDM networks using multiple vendors (module, router, open-line system and test equipment).

CMIS has established itself as the management interface of choice for next-generation pluggable modules, capable of managing both simple and advanced modules. CMIS provides a well-defined mechanism to initialize and manage optical and copper modules in a standard way, while still providing the capability to provide custom functionality. This commonality makes integrating different host platforms easier for both the host and module vendors.

OIF member companies participating in this event are **Adtran**; Alphawave Semi; Amphenol; Applied Optoelectronics, Inc.; Broadcom Inc.; Cadence Design Systems, Inc.; Casela Technologies; Ciena; Cisco Systems; Coherent; Credo Technology Group; Eoptolink; EXFO; Fujitsu Optical Components; Hisense Broadband; **Infinera**; Juniper Networks; Keysight Technologies; Linktel Technologies; Lumentum; MACOM Technology Solutions; Molex; MultiLane, Inc.; NEC Corporation; **Nokia**; O-Net Technologies; Precision Optical Technologies; Quantifi Photonics; Samtec; Semtech; Senko Advanced Components; Sicoya; Source Photonics; Sumitomo Electric Industries; Synopsys; **Telefonica S.A.**; VIAVI Solutions and Wilder Technologies. The interoperability demo is supported by participating companies Telefonica and LightRiver. Telefonica is the hosting consulting network operator, and LightRiver is a host for technology-specific pre-demonstration integration testing.

3.2.2 ITU-T and FSAN [TIM]

TIM is actively involved in ITU-T SG15 Q2 and FSAN activities. Two/three days plenary meetings are held every two months twice a year, in addition to intermediate calls and including dedicated workshops for specific topics of interest.

During this last year, Q2 finalized the Recommendations issued Amendment 1 of the High Speed PON system working at 50Gb/s line rate, including specification of the upstream at 50G (for ODNs of optical class N1) and triple coexistence. Concerning B5G-OPEN objectives, TIM is actively involved in activities related to development of new drafts of Recommendations for Very-High-Speed services PONs (>100G per wavelength channel), defining operator service, network and coexistence requirements and validating technological capabilities in support of VHSP systems. Coherent detection technology using, for example, frequency division (subcarrier) (FDM/FDMA) Sub-Carrier Multiplexing/Multiple Access (SCM/SCMA) and in place of the more traditional time-division multiple access (TDM/TDMA) IM-DD techniques is an interesting approach to achieve key objectives of VHSP, such as, capacity, link budget, and flexibility. Technical discussions on the opportunity of inclusion of downstream and, possibly, upstream flexible rate/modulation in VHSP systems are ongoing.

3.2.3 ONF TAPI North Bound Interface [CTTC]

CTTC and Telefonica have contributed to the standardization of the ONF TAPI 2.4 North Bound Interface, to be used between an orchestrator and an optical controller (or Open Line System Controller). The activities relate to R&D and standardization for the definition of data models and related interfaces. The activities involve the participation in weekly standardization meetings (weekly ONF OTCC TAPI meetings), representation in the OTCC Technical Steering Team (TST), the definition of use cases covering operators' requirements, the definition of the

supporting data models and, finally, the editorship of TAPI reference implementation agreements (RIA).

The main outcome at the time of writing is the release of TAPI 2.4.1 as a maintenance release of TAPI 2.4.0 completing pending points of the previous release. This corresponds to the release of version 2.4.1-RC1 of the ONF Transport API (TAPI) SDK. This SDK is being released under the Apache 2.0 license. The ONF Transport API (TAPI) project charted under the ONF Open Transport Configuration & Control (OTCC). As a non-exhaustive list, this activity has covered:

- Additional improvements to the use cases related to OAM and the use of new features 2.4.
- Introduction and consolidation of the generic concept of TAPI profiles, with a focus on the photonics layer, as well as the definition of transmission capacities to characterize Multiplexing Sequences in NEPs.
- Definition of new procedures to "extend" top connections, in support of Composite Link Connections
- Better support for modelling of regeneration (3R) and amplification functions
- Review current assumptions about connection navigation and partitioning, ensure proper use of Connectivity Services connection list and relationship with bottom connection and subsequent partitions.
- Elaboration of models of physical deficiencies (physical impairments) and use cases. Relationship with IETF models and related activities.
- Improvement in the use cases related to the user network interface (UNI) and related refinements.
- Definition and development of use cases related to route calculation. This includes use cases related to constrained route calculation, concurrent route precomputation, and bulk request processing.
- Reconsider the use of remote procedure calls (RPCs) and deprecate RPCs that have direct data model equivalents.

3.2.4 Openconfig [TID]

TID is actively contributing to Openconfig, participating in weekly calls and proposing new yang models covering specific gaps identified for telco use cases with special attention on optical disaggregation and IPoDWDM vendor agnostic control.

3.2.5 OpenROADM [TIM]

Telecom Italia has held the role of the chairperson of the consortium since October 2022 until September 2023; within this period, YANG models releases 12.1, 13.0 and 13.1 have been published. Release 14.0 is about to be published.

Three weekly meetings:

- plenary meeting, which is mainly dedicated to updating the YANG models and to all the internal formal aspects of the forum
- technical meeting addressing aspects of the transmission plan (to update the optical specifications of OpenROADM)

- a second technical meeting, introduced since June 2023, addressing specifically the update of digital specification of transceiver interfaces, comprising interfaces beyond 400G and with baudrates in the range of 128Gbaud; on these topics, a lively exchange of information takes place between OpenROADM and ITU-T Q11 and Q16

A new release of OpenROADM optical and digital specification, comprising also transceiver interfaces beyond 400G, is about to be published.

Considering the topics under discussion in OpenROADM, one of the most interesting for B5G-OPEN is the extension of optical specifications and models to cover multiband transmission. TIM introduced this topic in the new features wish list starting from release 13. The discussion on this topic is in a preliminary stage. Vendors are presenting and discussing their view on the subject.

In B5GOPEN WP4 the TIM OpenROADM agent has been updated to Release 12.1, with extensions for the management of multiband.

3.2.6 OpenXR forum [TIM, TID-TSA, BT]

TIM, TID and BT are participating at Open XR Forum periodic monthly meetings, and dedicated meetings for subgroups such as the Link Budget group. TIM provided use cases and forecast about network evolution in term of specifications and requirements for system vendors.

TID is provided a use case and PoC proposal to validate multivendor interoperability and dynamic bandwidth allocation XR optics with different vendor devices in IP and optical networks.

3.2.7 O-RAN [TIM]

TIM is member of O-RAN Alliance since end of 2018 and actively attends several Technical Groups and Governance committees (including Board and Executive Committee) to influence the evolution radio access networks. Concerning B5G-OPEN activities, TIM was actively following WG9 "Open X-haul Transport Work Group", that in 2022 edited, voted and approved five technical specifications: relevant topics were Xhaul testing, that included implications of recent solution documents on testing, and WDM-based Fronthaul networks including reference to Smart Tunable Optics and relative SmartTunable MSA, and MOPA (Mobile Optical Pluggable Alliance). For 2023, mainly face to face meetings were scheduled for most of the subgroups. Only Synchronization group, Packet Switching group and main WG9 meetings are running weekly. As TIM, in 2023 we are currently following the evolution of the main topics by accessing the documentation portal and not following anymore the online meetings.

3.2.8 TIP [TIM, TID]

B5G-OPEN partners such as Telefonica and TIM are actively contributing to the Open Optical & Packet Transport group, within Telecom Infra Project (TIP), that works on the definition of open technologies, architectures and interfaces in Optical and IP Networking.

The group is led by major operators, vendors and research institutions and works on different parts of the Transport network architecture, including optical transponders, line systems, IP access devices, open APIs and network simulation and planning tools.

Telefonica is co-chairing two projects in OOPT which are strongly related to B5GOPEN research work: MUST (Mandatory Use Case Specifications for SDN Transport) and MANTRA (Metaverse

ready Architectures for Open Transport). Telefonica participation in these groups is enabling a complete alignment between B5GOPEN and TIP specifications:

- ONF TAPI as optical NBI
- Netconf/OpenConfig as reference implementation for SBI in IP, Optical and IPoDWDM.
- Hierarchical SDN architecture comprising IP, Optical and multilayer domains

TIP-OOPT public documents can be found in (https://telecominfraproject.com/oopt/)

3.2.9   OpenSource Software

A large number of open-source software is used for the work of the different work packages. Furthermore, partners are planning to contribute to open-source software packages such as ONOS SDN. Examples for used software are given in the following list:

- **ONOS SDN** controller for preliminary studies on control plane architecture
- **Openstack** as VIM
- **Kubernetes** as container management system
- **Netopeer** and related software for Netconf prototype testing
- **Docker** to dockerize applications and function
- **Kafka** and **Redis** as telemetry systems
- **Grafana** for dashboard visualization
- **SONIC** as a network operating system for hybric packet-optical nodes
- **Net2Plan** as network planner
- **GNPy** for estimating the power of the non-linear interference
- **BMv2** for emulating a P4-based switch
- open-source operating systems, languages, compilers, and tools
- open-source libraries to develop part of our software (Boost C++ Libraries)

3.3   B5G-OPEN WEBSITE

3.3.1   Main contents

The project website - https://www.b5g-open.eu/ - has been constantly updated.

For example, the NEWS area includes pieces of news, informing the public audience about project events (e.g., plenary meetings), relevant publications (JOCN/JLT journals, OFC/ECOC conference papers), participation to workshops, and disseminations events targeting the broad community.

3.3.2   Website statistics

Figure 3.1 shows the project web site statistics in terms of number of visitors. A remarkable result of more than 14.500 visitors was achieved during the first year of the project, which increased to more than 24.000 in Year 2.

This result is even more relevant if compared with the results achieved by other H2020 projects, like H2020 METRO-HAUL which focused on the same topic of optical networking between 2017 and 2020. The METRO-HAUL website registered 2600 visitors at the end of Year2.

Figure 3.2 shows the daily statistics. It is possible to appreciate peaks of more than 800 visitors in a single day.
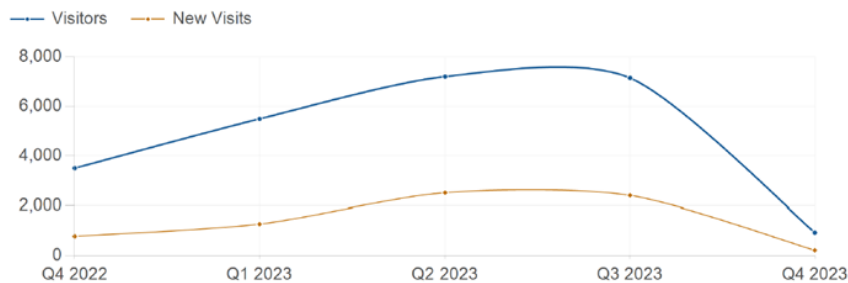
Visitors Trend
10/1/2021 - 10/28/2022
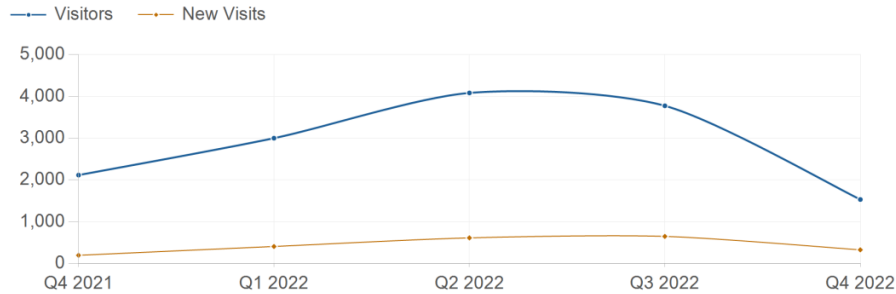
Date	Visitors	Unique Visits	New Visits	Return Visits
Q4 2021	2,118	198	198	0
Q1 2022	3,001	441	409	32
Q2 2022	4,084	693	615	78
Q3 2022	3,776	781	650	131
Q4 2022	1,534	457	329	128
Total	14,513	2,570	2,201	369

Visitors Trend
10/28/2022 - 10/12/2023

Date	Visitors	Unique Visits	New Visits	Return Visits
Q4 2022	3,506	782	782	0
Q1 2023	5,498	1,413	1,275	138
Q2 2023	7,206	2,747	2,520	227
Q3 2023	7,151	2,797	2,412	385
Q4 2023	930	398	219	179
Total	24,291	8,137	7,208	929

Figure 3.1: Project website statistics – visitors in Year 1 (top) and Year 2 (bottom)

Visitors Trend
10/1/2021 - 10/28/2022
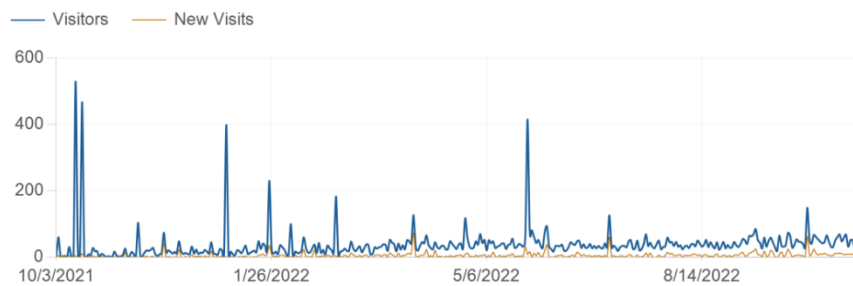
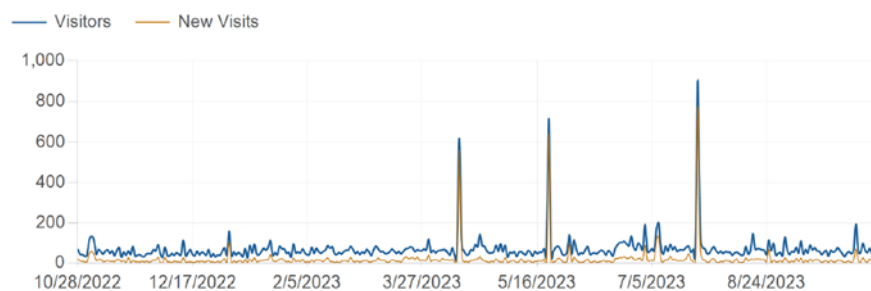**Visitors Trend**
10/28/2022 - 10/12/2023

Figure 3.2: Project website statistics – visitors per day in Year 1 (top) and Year 2 (bottom)

3.4 SOCIAL MEDIAS

In addition to the B5G-OPEN website, we are making usage of the various social platforms to increase the possibilities of dissemination of the project activities.

We selected the following widely used social medias:

- LinkedIn (https://www.linkedin.com/company/b5g-open/?viewAsMember=true)
- YouTube (B5G-OPEN Project - YouTube)
- Twitter (@B5G-OPEN)

Details on the utilizations of these three platforms are provided hereafter.

3.4.1 LinkedIn

LinkedIn is one of the most used social media platforms for professionals and it is the main social media where WP6 actively posts about the project and its member activities, such as organized workshops as well as any scientific achievement and outreach initiatives. B5G-OPEN has been publishing its scientific achievements, in terms of participation to conferences and publications of the results on the leading journals. On 29th of Nov. 2022, we counted

Item	Y1	Y2
Page views	569	560
Unique visitors	168	236

Custom button clicks	53	6
Followers	87	189

- with an average of visit per page of 1.6. Fig. 4.4 shows the evolution of visitor over time.
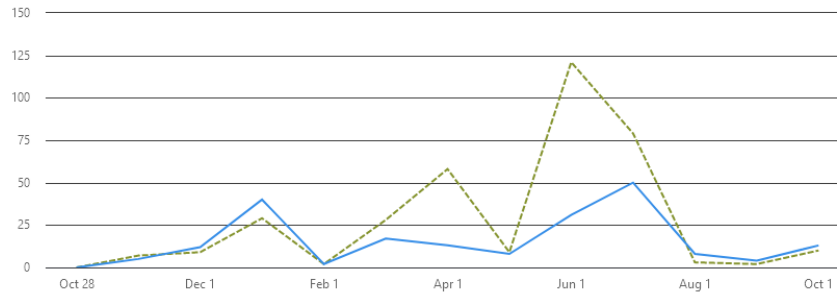

Fig. 4.4. LinkedIn visitors over the last year (Oct. 2022 – Oct. 2023).

3.4.2 YouTube Channel

YouTube is the most-known online video platform, and B5G-OPEN project uses this resource to upload multimedia content. The B5G-OPEN YouTube channel was created in QMR2. As of the writing of this documentation, we currently have two playlists available to public:

Playlist	Video	Views	Likes
B5G-OPEN workshop	ICT 52 Workshop on 6G	316	3
B5G-OPEN plenary meetings	[B5G-OPEN] 3rd Plenary meeting Barcelona (UPC) 2022/10/18 (1)	65	1
	[B5G-OPEN] 3rd Plenary meeting Barcelona (UPC) 2022/10/18 (2)	139	4
OFC 2023	A talk with project coordinator at OFC 2023	32	3
	Telemetry Demo at OFC 2023	37	1
	Distributed Architecture Supporting Measurement Aggregation and Event Telemetry	8	0
EuCNC 2023	SDN Control of Multiband Optical Networks with externalized path computation exploiting device manifests.	0	0

Note: The previous hyperlinks redirect to B5G-OPEN videos in YouTube.

The YouTube's statistics on 6th of Oct. 2023 for the 1-year period are:

- 281 views
- 627 impressions
- 10.1% Impressions click-through rate
- 0:27 average view duration

Fig. 4.5. shows the YouTube channel views and average view duration over time.
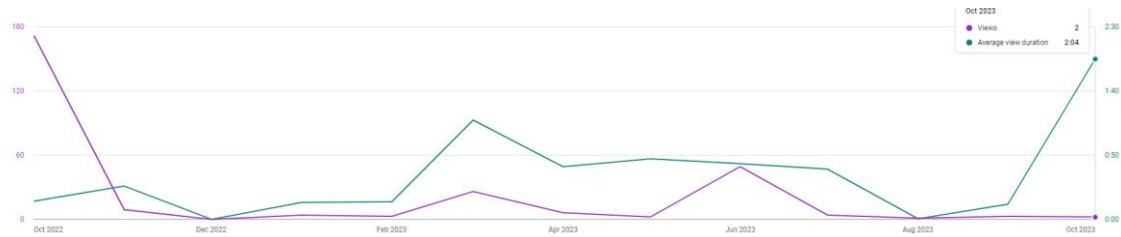
20

Fig. 4.5. YouTube channel views and average view duration (Oct. 2022 – Oct. 2023).

3.5 WORKSHOP ORGANISATION

- Gender and diversity workshop within IMOC 2023

    Preparation and organization of the gender and diversity workshop "Talent and career in research: The role of mentoring to foster diversity and inclusion" in the framework of the 20th SBMO/IEEE MTT-S international microwave and optoelectronics conference (IMOC) 2023 that will be held at CTTC premises in Castelldefels on 8th November. Workshop organizers from B5G-OPEN include Laia Nadal and Michela Svaluto Moreolo. More information can be found at:

    https://www.events.sbmo.org.br/imoc2023/pagina/33/workshops

- Workshop organized by Luis Velasco at ONDM 2023 in Coimbra by Luis Velasco (UPC), João Pedro (INF-P), Marc Ruiz (UPC) entitled "Challenges of optical communications in the 6G era: a view from EU projects".

- OPTICA Incubator in Washington, entitled "Learning from Light: An Optica Incubator on Machine Learning", 13 - 15 September 2023, Optica Global Headquarters, Washington, DC, USA. Antonio Napoli presented also work carried out within B5G-OPEN to improve the throughput in next generation optical communications system by compensating for nonlinear propagation effects.
    https://www.optica.org/events/incubator_meetings/2023/learning_from_light_an_optica_incubator_on_machine/

3.6 DEMOS

- **OFC 2023**

There were 13 B5G-OPEN works being presented at the OFC 2023. Full list of papers is available: https://www.b5g-open.eu/b5g-open-at-ofc-huge-success/

The following telemetry demo has been presented at the conference and the video is also available here: https://www.youtube.com/watch?v=yGmC9Pp1dQQ
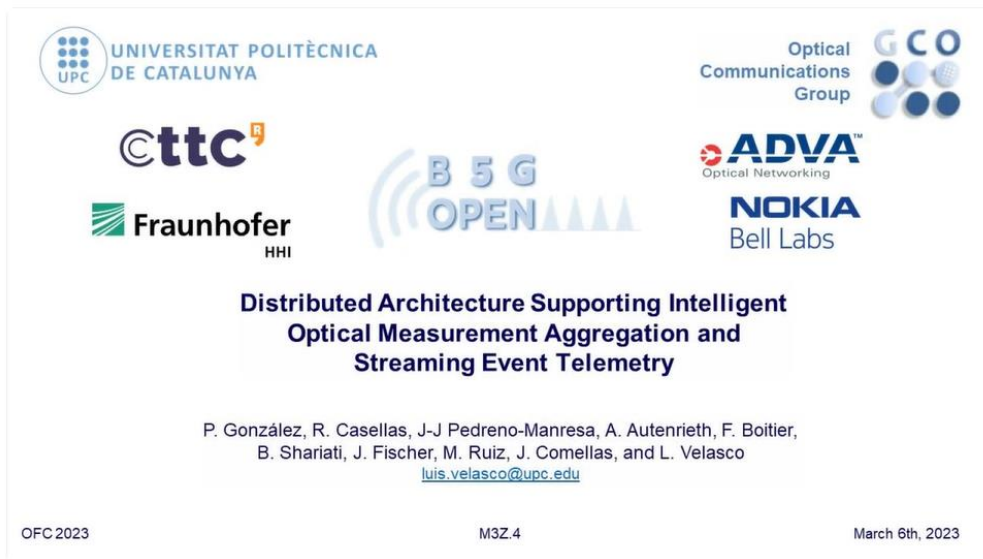
Figure 3.3: Telemetry Demo at OFC 2023

- **Booth EUCNC 2023**

B5G-OPEN Project was extremely active at the EuCNC 2023 Conference in Gotenburgh, Sweden. A dedicated B5G-OPEN booth presented all project activities and results. In addition, two Posters showed relevant project activities in the field of multiband data plane infrastructure and packet-optical networking. Furthermore, Emilio Riccardi (TIM) provided a B5G-OPEN talk on "An operators' perspective on the migration to multi-band networks" at the Special Session entitled "Novel technologies in disaggregated packet-optical networks".

Figure 3.4: B5G-OPEN Booth at EUCNC 2023

- **ECOC 2023**

The following joint demo has been presented at ECOC 2023 titled: "Modular Control Plane Implementation for Disaggregated Optical Transport Networks with Multi-band Support". The video of the demo is available here: https://www.youtube.com/watch?v=3CWxFnRwxo4
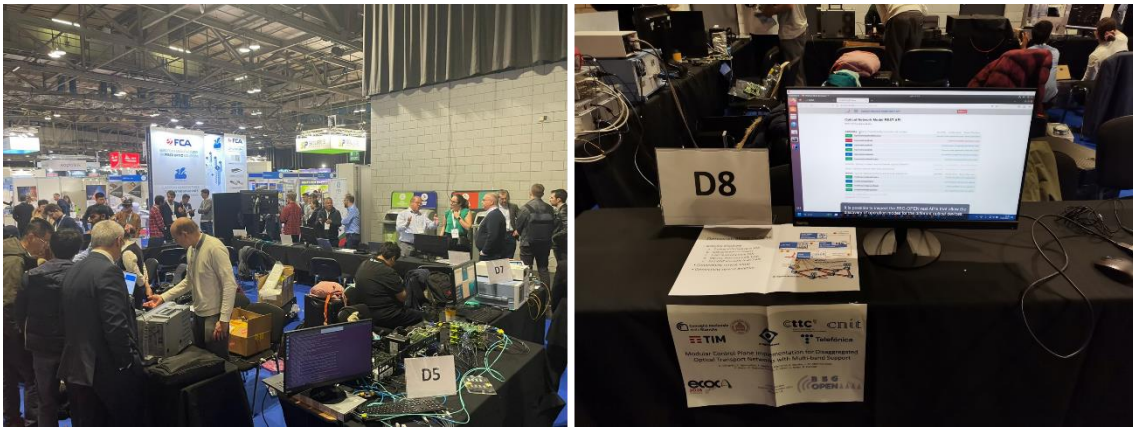
Figure 3.5: B5G-OPEN Demo at ECOC 2023

3.7 NEWSLETTERS

During the second year of the project 4 newsletters have been published:

- Newsletter 2: the topic of this newsletter was the participation of B5G-Open and the presentations and articles shared during ECOC 2022. In specific they were particularly involved in the Multiband Workshop.

- Newsletter 3: the topic of this newsletter was the publication of the first three deliverables of the project at the end of the project's first year. It included a brief overview of these deliverables is provided below.
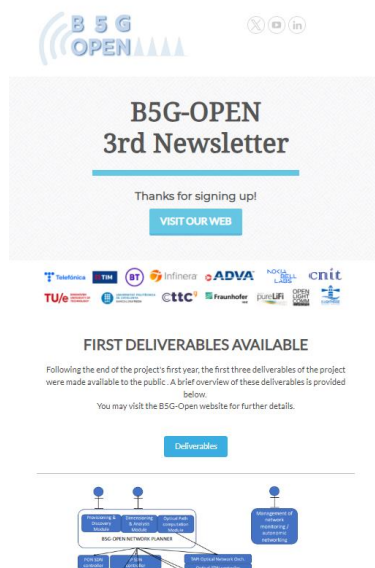
- Newsletter 4: The topic of this newsletter was the presentation of 13 works during OFC 2023 in San Diego, CA.
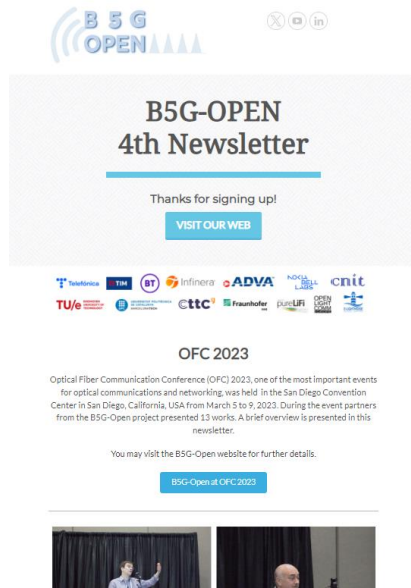
- Newsletter 5: The topic of this newsletter was the 5 innovations accepted in the context of B5G-Open by the EC's Innovation Radar.

4 EXPLOITATION PLAN

4.1 INDIVIDUAL EXPLOITATION PLAN

This section briefly presents the exploitation plan for individual partner.

4.1.1 TID

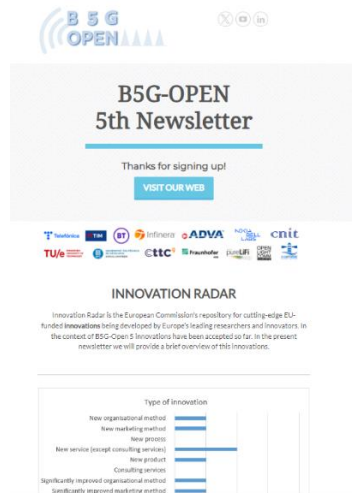As a Telecom operator, Telefonica aims to implement in the future key networking solutions proposed in B5GOPEN such as: multiband C+L transmission, sliceable transceivers, IP and optical convergence and vendor agnostic transport SDN. According to it, Telefonica is on the one hand contributing in technoeconomic and demonstration activities in B5GOPEN and on the other hand is actively working in standardization and industrial fora (e.g IOWN, OIF, TIP, IETF, OpenConfig, openXR forum, and ONF) to promote the implementation of standard commercial products which could be requested by Telefonica in procurement processes from 2025.

4.1.2 TIM

TIM Technology Innovation department is actively contributing to the project by providing information about currently deployed networks architectures and topologies, type of transported services, traffic volumes and their expected evolution. Based on these data, TIM collaborates with the other partners in studying the applicability of new technologies and innovative architectures addressed by B5G-Open in different segments of the network. These studies comprise the evaluation of the ability of these new technologies and architectures in coping with the expected traffic increase and services evolution, and in consenting cost and power consumption containment. TIM is also planning to experimentally evaluate some of the B5G-Open technologies in its laboratories, in collaboration with other partners, in the last period of the project.

The knowhow achieved by all these activities will be effectively exploited over the coming years, in the evaluation of new technologies as they become commercially available (Multiband and point-to-multipoint (P2MP) are considered with particular interest) and as a reference for the future TIM's Investment Plans. Results will help TIM innovation and engineering departments to write RFIs and RFQs about these new technologies, as well TIM marketing to explore new business opportunities enabled.

4.1.3 BT

BT needs to plan its network (as the main asset) and services evolution (e.g. connectivity, TV services, etc.) as well as the migration strategies. The results and the lessons learnt from the B5G-OPEN project are expected to enable informed decisions. As new fibre access technologies are being deployed and 5G services (and beyond in the future) are being rolled out, the growing capacity demand places a large strain on the fibre network. Besides, new services with very stringent KPIs, such as uRLLC, requires more connectivity and service resources thus challenging the viability of the business as the revenues per Gb/s continue to fall, which is compounded by competitions and regulation. The exploitation of MB in optical fibre along with the realisation of a proactive autonomous network making use of disaggregation with distributed compute and storage resources is the right path to take in the evolutions path that service providers are forced upon. Standardisation is compulsory so the necessary technologies can be developed relying on

volumes that lead to minimising the costs. Therefore, it is part of the strategy and exploitation to take the new technologies through the SDO routes.

4.1.4 INF-D

Infinera will leverage the collaboration and technology developed in the scope of B5G-OPEN in the following aspects: (i) Developing and introducing resource provisioning algorithms (such as e.g. digital subcarrier management) for P2MP transceivers in the Infinera research tool (internal) and in its Transcend SDN controller suite; (ii) advanced network optimization and novel architecture to support the use cases proposed within B5G-OPEN, also in term of techno-economics – in this context we also extended our tool to take into account the usage of a PIC-based OADM used in a multi-partner experiment that will take place next April 2024; and (iii) acquiring more in-depth modelling of MB transmission/switching performance, and subsequent application into offline planning tools and NMS/SDN products, validated via techno-economic analyses using advance transmission modelling.

The results obtained by INF-G are regularly presented externally (at conference, published on magazines) and internally (marketing and R&D teams).

4.1.5 INF-P

Infinera Portugal will ensure that the key findings of B5G-OPEN are disseminated both to the appropriated stakeholders of the Infinera group (including, for example, product management, R&D, and marketing teams) and to the public (e.g., via scientific publications, social media).

By covering topics ranging from high-capacity solutions for backbone/regional networks to low-cost and flexible architectures for metro-aggregation networks and to the increased adoption of automation capabilities, B5G-OPEN is aligned with current and future needs of Infinera's customers. Among the areas of investigation in B5G-OPEN, the following ones are of particular interest to Infinera Portugal and will more likely be the subject of exploitation: (1) efficient design and operation of optical networks exploiting transmission over a wideband, e.g., ~12 THz in a SuperC+L-band system or >15 THz in a C+L+S-band system; (2) optimized utilization of Raman amplification to improve the performance of wideband transmission systems; (3) cost-effective and flexible optical node architectures and planning strategies to support point-to-multipoint connectivity in metro-aggregation networks using coherent pluggable transceivers; and (4) improved control and optimization of optical networks, leveraging digital twin solutions.

The set of Infinera products that may in the future incorporate solutions from B5G-OPEN or, in general, be influenced by the research performed in the scope of the project, include Infinera's GX line system, Transcend suite of network management system and transport controller solutions and the TNPS planning tool.

4.1.6 ADTRAN

Project results will be distributed internally and presented to the business development and product line management teams. These teams will solicit customer feedback to new concepts and will decide on the productization. Results will be published to the scientific community, to potential and key customers, as well as be carried into SDOs, especially ITU-T, where ADTRAN is a regular contributor.

ADTRAN will develop in B5G-OPEN new approaches to utilize a wider optical bandwidth of optical fibres. Especially, innovations in MB amplification and methods to use multiple transmission bands will be developed. Some aspects of the solution, for instance a fibre continuity check required for Raman amplification, might be based on existing implementation in ADTRAN's products. This will enable a seamless integration of the developed solution into ADTRAN's product portfolio.

In close cooperation with ADTRAN's product line management, European and global market requirements will be gathered and will impact the project work. A close cooperation between the Advanced Technology department and the R&D department will enable a quick transfer of the knowledge gathered within the project. ADTRAN has already been contacted by customers to get a better understanding of future network requirements.

4.1.7 Nokia

Nokia Bell Labs is actively contributing towards the goal of massively monitoring the optical network infrastructure so as to see the health of the network, potentially in real-time. These monitored values are then leveraged through machine learning applications to optimize the point-to-point lightpath connection and to detect and localize anomalies.

On the monitoring side, current commercial transponders mainly monitor the performance quality, chromatic dispersion, polarization mode dispersion and received power. In the B5G-OPEN project, we developed a monitoring technique capable of getting the power profile along the transmission (like an OTDR) from a single received point. This is very powerful and has a two-fold objective: (i) to detect and localize loss anomalies anywhere in the line, ii) to reduce the design margin.

We investigated several approaches to perform this power profile monitoring relying on SPM or XPM nonlinearities. We are also doing a sensitivity analysis on the cost and power consumption of such "power profile" technique with respect to the traditional OTDR one. This will give guidelines for a future product implementation.

The Nokia products targeted for this innovation is the Nokia 1830 PSS hardware platform and the Nokia Wavesuite software tool. This monitoring technique is also reported in the innovation radar (see Section 4.6).

4.1.8 CNIT

CNIT, as a Research and Technical Organization (RTO), is using the project platform and the innovative white box solution enhanced with network programmability for promoting basic and applied research in the various fields of ICT, coordinating activities among the member universities with particular attention to the definition, promotion and implementation of innovative industrial projects of significant size. For example, CNIT organized dedicated workshops with selected member Universities (e.g., Scuola Superiore Sant'Anna) to present and promote the project activities. CNIT is also using this technical innovation and developed knowledge to strengthen the industrial collaboration and technology transfer particularly with Telecom Operators. TIM is funding a PhD student co-supervised by CNIT on the B5G-OPEN project topics.

4.1.9   CTTC

CTTC is actively working within B5G-OPEN with different contributions and developments/solutions which mainly include: (i) the investigation and implementation of a MB S-BVT prototype capable to transmit over the C- and the S-bands towards extending SoA transceiver capabilities; (ii) Implementation of an OpenConfig SDN agent capable to reconfigure the MB S-BVT according to the network needs; (iii) Contribution on the data modelling of SDN telemetry agents, zero-touch networking, and design/implementation of a telemetry system; (iv) Development of a SDN controller suitable for MB networks. All these advancements and solutions explored within the project will produce key results and high-quality research to publish in high-impact journals and scientific conferences. Additionally, CTTC will conduct educational activities such as seminars, webinars, and workshops, to share the acquired project knowledge and findings with students, researchers, and industry professionals. This approach will foster knowledge dissemination and create new opportunities. To support the research performed within B5G-OPEN, CTTC experimental facilities have been extended and upgraded towards supporting MB technology ensuring that CTTC research remains at the forefront of optical communications also enabling new opportunities of collaboration. Thanks to the knowledge acquired in the project, CTTC will actively contribute to the training of future experts in B5G-OPEN topics. We will engage with Ph.D. students and provide mentorship, research opportunities, and access to our advanced experimental facilities. This initiative supports the development of a skilled workforce capable of advancing current optical communication technologies. Finally, to foster collaboration with the industry, CTTC will engage in technology transfer activities. These include sharing insights, research findings, and innovative solutions with industry partners thanks to the expertise acquired within B5G-OPEN.

4.1.10   UPC

UPC contributions are on telemetry, digital twins, and network automation. As university, the primary exploitation is to use the developed material and knowledge shared in the project for educational program including classes and lectures to undergraduate as well graduated students and PhD students.

4.1.11   HHI

HHI contributions include DSP-based network tomography for monitoring, the multi-band node prototype, and the experimental dataset generation. HHI, as a research organization, exploits the developed know-how and expertise to perform further research and IP developments and use them in future research projects. Moreover, it will include the developed DSP algorithm in its DSP library, which is a commercially available software solution. In addition, along the way of delivering its commitments, it has trained master's and PhD students and will continue to do so in terms of training highly skilled researchers.

4.1.12   OLC-E

OLC-E has developed a multi-band routing engine that is built upon a physical layer aware routing algorithm (PLI-aware RMSA). This routing engine play a key role in OLC-E's strategy to develop innovative services. Efforts are underway to develop the appropriate IPR.

4.1.13   ELIG

E-lighthouse actively works to achieve the goals of the B5G-OPEN project. Our primary objective is to enhance the capabilities and performance of the E-Lighthouse Network Planner, as part of the B5G-ONP module, and increase the value of the research results acquired during the project by incorporating these benefits into optimization tools in the field of network management. The key aspects of E-lighthouse's exploitation plan are:

- Development of Innovative Services: E-lighthouse is committed to using research results to generate practical products and services that add significant benefit to new or existing commercial solutions. Collaboration with the technology partners and project experts will be key in turning scientific advancements into solutions that meet the market's demands.
- IPR: It is important to protect the intellectual property resulting from previous research, so appropriate mechanisms will be identified to secure the work carried out. Strategic formulas will also be explored for future partnerships or the granting of specific authorizations to broaden the scope of the development obtained.
- Marketing Strategy: Commercial positioning of the company and its optimization solutions in the telecommunications market. This involves conducting in-depth market and competitive analyses, identifying target segments and devising effective plans. Strategic alliances will also be established with telecom operators and integration companies to promote the adoption of the solutions developed by E-lighthouse.
- Funding and Investment Pursuit: Seeking sources of funding and investment to support the commercialization of our tool. This includes exploring European funding programs and other sources of capital to strengthen our marketing, production, and expansion efforts. E-lighthouse is committed to efficient financial management.
- Impact monitoring and evaluation: Measurement of the impact of research and development on the telecommunications market. To this end, data will be collected on technology adoption rates, economic benefits generated and key performance indicators. This information will be used to continuously improve the products and services offered by E-lighthouse.

Furthermore, E-lighthouse has earned recognition on the Innovation Radar platform of the European Commission as a 'key innovator' for their work on the innovation titled, "Holistic network optimization and planning tool for IT and network resources, with optical multi-band capabilities." This achievement is a pivotal milestone, offering E-lighthouse an exceptional opportunity to exploit their innovation and broaden their market influence. This fact is in line with the company's primary exploitation goal is to capitalize on their research outcomes, ultimately advancing the telecommunications sector and contributing to both the sustainable development of their company and society at large.

4.1.14 TUE

TUE contributions is on novel MB switches and the design of photonic integrated OADM to be employed in the demonstrator. As university, the primary exploitation is to use the developed material and knowledge shared in the project for educational program including classes and lectures to undergraduate as well graduated students and PhD students. Moreover, in collaboration with the TUE Innovation Industry, the Gate, we will consider possible exploitation of the PIC-OADM for further technological development and potential application and validation via test trial with B5G-OPEN industrial partners. Based on the outcome results and techno-

economical investigation, founding of spin-off company would be considered with the support of the Gate.

4.1.15 PLF

Within the B5G-OPEN project, PLF stands at the forefront of integrating enhanced LiFi connectivity, synergizing traditional optical communication channels with the future demands of 5G and beyond. The exploitation effort would be made around the innovation titled 'ENHANCED LIFI CONNECTIVITY FOR NETWORK INTEGRATION' which offers a seamless merger of LiFi with broader networks, and has been highlighted by the Innovation Radar recently.

Our recent completion of the IEEE802.11bb standard showcases our leadership and dedication to LiFi advancement within the 802.11 community. As a foundational member of the Light Communication Alliance (LCA) and an active participant in the Networld SME Work Group, PLF is strategically positioned to champion the growth and acceptance of LiFi technology. By actively promoting and exploiting the insights from B5G-OPEN in these influential forums, we further the reach and implementation of LiFi innovations.

At the end of B5G-OPEN project, we are contributing to a real-life demonstration with our development. This demo will not only highlight the project's tangible outcomes but also serve as a cornerstone for PLF's exploitation strategy. By showcasing and leveraging the insights from this demonstration, we aim to continue the exploitation effort on LiFi technology beyond the B5G-OPEN project.

4.2 JOINT/GROUP EXPLOITATION PLAN

- Network and Service Operators

Network and service operators will form collaborations with equipment manufacturers to jointly implement B5G-OPEN's innovations into their network infrastructure. This cooperative effort aims to enhance network capacity and improve service quality. By sharing expertise and resources, operators and manufacturers can collectively leverage B5G-OPEN's solutions to optimize resource allocation, implement efficient power management, and maximize spectral usage. Additionally, operators will collaborate with SMEs and research institutions to explore innovative use cases and applications, further expanding the impact of B5G-OPEN's innovations.

- Network Equipment Manufacturers

Manufacturers will engage in collaborative projects with network operators to seamlessly integrate B5G-OPEN's technology into their product portfolios. This collaborative approach allows manufacturers to develop advanced network equipment that meets the evolving needs of operators. Joint efforts will focus on embedding B5G-OPEN's solutions into equipment. By working closely with network operators and SMEs, manufacturers can ensure that their products align with industry standards and cater to diverse market requirements.

- SMEs

SMEs will actively seek collaboration opportunities with both network operators and equipment manufacturers to jointly exploit B5G-OPEN's innovations. By partnering with these key stakeholders, SMEs can tailor B5G-OPEN's solutions to address specific industry challenges and market demands. Joint projects will focus on the development of customized solutions that enhance SMEs' competitiveness and market presence. Furthermore, SMEs will collaborate with academic and research institutions to validate and fine-tune these solutions through research projects and experiments.

- Academic and Research Institutions

The academia and research institution partners will include and reuse the deployed solutions and results in additional contexts, target different markets. Institutions will use the project platform for promoting basic and applied research in the various fields of ICT, exploit the project to operate towards the training of PhDs and the preparation of expert researchers. The partners will apply the developed know-how to extend their experimental facilities. The scientific production resulting from these research activities will allow them to strengthen their position in the optical transport and networking research community and to help in technology transfer activities, enhancing different product/innovations of their respective portfolios and strengthen collaboration with the industry. The project results will also be exploited by educational activities, contribution to subjects, courses, and workshops as well as M.Sc. and PhD. graduation projects.

4.3 INNOVATION RADAR HIGHLIGHTS

Five innovations from B5G-OPEN have been summarised and submitted to the European Commission's innovation radar questionnaire. At the time of this report being prepared, all these five innovations have been analysed and highlight by the innovation radar platform. In this section, we present a high-level summary and introduction of the five innovations, as well as the analysis result from innovation radar.

1) "Fibre optical communication platform offering increased capacity over existing fibre infrastructure with good transient performance" by ADTRAN
2) "Holistic network optimization and planning tool for IT and network resources, with optical multi-band capabilities" by ELI-G
3) "Improved power profile monitoring with accurate estimation for both point-to-point or optical mesh connections" by Nokia
4) "Optical Multi-Band PCE exploiting a Physical Layer Impairment-aware Routing Modulation and Spectral Assignment (PLI-aware RMSA) Algorithm" by OLC-E
5) "Enhanced LiFi connectivity for network integration" by PLF

4.3.1   Innovation #1: Fibre optical communication platform offering increased capacity over existing fibre infrastructure with good transient performance

Existing fibre optical systems are soon no longer able to cope with the increased demand for capacity. Therefore, the capacity of an existing transmission system is increased by introducing the multiband technology. An important aspect is to provide transient performance that is comparable with the current single band version at reasonable cost. In an extensive study, the maximum capacity that can be provided over links with a given margin has been determined.

This innovation is led by ADTRAN.

Details of this innovation, and how it was categorised by the analysis, are as follows:

- Innovation Title: FIBRE OPTICAL COMMUNICATION PLATFORM OFFERING INCREASED CAPACITY OVER EXISTING FIBRE INFRASTRUCTURE WITH GOOD TRANSIENT PERFORMANCE;
- Market Maturity of the Innovation: Tech Ready;
- Market Creation Potential of the innovation: Addresses needs of existing markets

4.3.2   Innovation #2: Holistic network optimization and planning tool for IT and network resources, with optical multi-band capabilities

This innovation is settled in the control plane, responsible for coordinating and orchestrating IT and network resources in optical multi-band scenarios. It offers functionalities for designing, optimizing, and planning the deployment, management, and configuration of services and resources. Additionally, it features a user-friendly Graphical User Interface (GUI) that aims to improve the Quality of Experience (QoE) and simplify interactions with the underlying network components.

This innovation is led by e-LightHouse Network Solutions (ELI-G).

Details of this innovation, and how it was categorised by the analysis, are as follows:

- Innovation Title: HOLISTIC NETWORK OPTIMIZATION AND PLANNING TOOL FOR IT AND NETWORK RESOURCES, WITH OPTICAL MULTI-BAND CAPABILITIES;
- Market Maturity of the Innovation: Business Ready
- Market Creation Potential of the innovation: Moderate

4.3.3   Innovation #3: Improved power profile monitoring with accurate estimation for both point-to-point or optical mesh connections

Power profile monitoring is a new monitoring technique allowing to localize the power losses along the transmission line with very good location accuracy (<1km). It is a competitive alternative to optical time domain reflectometry (OTDR) which needs to deploy a specific hardware device span by span.

The pioneering technique did not allow the estimation of power losses, which we added in this innovation. In addition, we make it more scalable for optical mesh network, as it leverages lightpath diversity to enhance the accuracy of both the estimation and the localization and also to simplify the estimation.

This innovation relies on the development of a specific advanced signal processing algorithm which has been optimized to be able to process only a part of the transmission link to reduce computational complexity and latency. If leveraging lightpath diversity, an additional algorithm has been developed and is deployed in a centralized management and control plane to get correlated information from multiple lightpaths.

This innovation is led by Nokia.

Details of this innovation, and how it was categorised by the analysis, are as follows:

- Innovation Title: IMPROVED POWER PROFILE MONITORING WITH ACCURATE ESTIMATION FOR BOTH POINT-TO-POINT OR OPTICAL MESH CONNECTIONS;
- Market Maturity of the Innovation: Tech Ready
- Market Creation Potential of the innovation: Addressing the needs of existing markets and existing customers
- Women-led innovation

4.3.4 Innovation #4: Optical Multi-Band PCE exploiting a Physical Layer Impairment-aware Routing Modulation and Spectral Assignment (PLI-aware RMSA) Algorithm

The multi-band PCE (MB-PCE) is tasked to complete computationally intensive operations so it is externalized to the SDN control plane. The MB-PCE consists of a routing engine that exploits a Physical Layer Impairment-aware Routing and Spectral Assignment Algorithm (PLI-aware RMSA) and it is equally applicable to both end-to-end transparent and translucent paths. The MB-PCE retrieves network topology including any network status updates from telemetry. The PLI-aware RMSA also gets as input the deployed optical transmission system parameters as well as the traffic components of the existing and the new connections.

This innovation is led by OpenLightComm Europe (OLC-E).

Details of this innovation, and how it was categorised by the analysis, are as follows:

- Innovation Title: OPTICAL MULTI-BAND PCE EXPLOITING A PHYSICAL LAYER IMPAIRMENT-AWARE ROUTING MODULATION AND SPECTRAL ASSIGNMENT (PLI AWARE RMSA) ALGORITHM;
- Market Maturity of the Innovation: Business Ready
- Market Creation Potential of the innovation: Noteworthy

4.3.5 Innovation #5: Enhanced LiFi connectivity for network integration

This innovation is an enhancement on existing LiFi system on the connectivity for network integration. It helps to integrate LiFi access technology into a larger scale network including 5G, Wi-Fi access technologies. The objective is to introduce a comprehensive solution comprising a LiFi SDN agent for LiFi Access Points (APs) and a LiFi SDN controller to current LiFi system for managing and configuring LiFi APs and networks.

This innovation also entails the development of advanced algorithms specifically designed to address the challenges posed by user movement in LiFi environments. As users move within the coverage area, channel conditions in LiFi networks tend to fluctuate. To ensure optimal Quality of Service (QoS) even in the presence of changing channel conditions, these algorithms will dynamically configure and control LiFi APs.

The algorithms will leverage the capabilities of the LiFi SDN controller to monitor and adapt the LiFi APs based on real-time feedback regarding user movement and channel conditions. By continuously optimizing the configuration of LiFi APs, the innovation aims to provide reliable connectivity, seamless handoffs, and uninterrupted user experience in LiFi environments.

This innovation is led by pureLiFi (PLF).

Details of this innovation, and how it was categorised by the analysis, are as follows:

- Innovation Title: ENHANCED LIFI CONNECTIVITY FOR NETWORK INTEGRATION;
- Market Maturity of the Innovation: Exploring
- Market Creation Potential of the innovation: Very high

5 SUMMARY

This document provides a comprehensive overview of the B5G-OPEN project's activities in communication, dissemination, and standardization during its second year. We focus on the key achievements and highlights of this period while omitting redundant details from Year 1.

Our internal communication strategy leverages administrative tools such as MS Teams to facilitate effective collaboration among project partners. While some elements, like the repository and file system, remain consistent with the previous year, we emphasize activities unique to Year 2.

Externally, our dissemination strategy continues to thrive, with the project website serving as a dynamic hub for sharing updates and research findings. Active engagement on social media platforms enables us to connect with stakeholders, communicate project progress, and stimulate meaningful discussions.

In the realm of publications and events, our performance has exceeded expectations. Contributions to industry conferences and scientific journals in the second year significantly surpassed initial targets. This underscores our commitment to disseminating high-quality research and active involvement in standardization activities.

Additionally, our active involvement in 5G-PPP initiatives and various standardization groups has effectively synchronized our research with industry standards, fostering progress in the broader telecommunications domain.

A notable accomplishment in the second year is the acceptance of all five innovations submitted to the European Commission's Innovation Radar. This recognition underlines the innovative character of our project and the potential impact of our contributions.

In conclusion, the second year of the B5G-OPEN project has seen significant progress in communication, dissemination, and standardization activities. These achievements reflect our dedication to driving innovation, knowledge sharing, and collaboration. Entering Year 3, we will continue our dedicated efforts in communication and dissemination to better promote B5G-OPEN results and create a significant impact.

6 APPENDICES A COMPREHENSIVE LIST OF YEAR 2 DISSEMINATION ACTIVITY LIST

Publication and
Dissemination Activiti